



# **COST OF INSTANTIZING NONFAT DRY MILK**

## ABSTRACT

economic engineering method is used to develop processing and fixed investment costs for instantized nonfat dry milk powder. Total cost is analyzed on basis of milk powder processed and packaged in one type of consumer pack--a 20-quart (4-pound) carton. Results indicate that raw material costs represent more than four-fifths of total cost, with packaging costs accounting 10 percent, and instantizing and administrative expenses making up the balance. Cost centers are developed for administration, powder handling, instantizing, and packaging.

words: Milk products, Milk product costs, Instantized milk products.

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## SUMMARY

Instantizing and packaging regular nonfat dry milk in 20-quart (4-pound) cartons costs 40.7 cents per pound of finished product. Of this total cost, raw materials account for 81.5 percent, packaging 10-percent, while instantizing and administrative expenses make up the remainder.

These cost estimates were developed for a synthesized plant operating under assumed conditions for 1971 and do not pertain to a specific instantizing operation. In this economic engineering study, the model plant required a capital investment of about \$788,000. The building was located on 2 acres of land and contained 17,425 square feet of space for the instantizing and associated operations.

For analysis, the instantizing operation was separated into four cost centers: administration; powder receiving, handling and warehousing; instantizing; and packaging. Based on an annual production of 8,640,000 pounds of instantized nonfat dry milk powder, prorated operating costs for the major cost centers were: 1.01 cents per pound of finished product for administration; 0.65 cent per pound for powder receiving, handling, and warehousing; 0.92 cent per pound for instantizing; and 4.21 cents per pound of finished product for packaging. Also, a powder loss due to processing amounted to 0.50 cent per pound and the process license fee was 0.25 cent per pound.

# COST OF INSTANTIZING NONFAT DRY MILK

by

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## INTRODUCTION

The major factor limiting the sale of nonfat dry milk powder for home use after World War II was its poor dispersibility in water (4, p. 4.) <sup>1/</sup> Development of the "instantizing" process in the early fifties solved this problem. Today, most nonfat dry milk packaged and sold for use in the home is instantized.

Currently, two general methods are used in instantizing nonfat dry milk. In the "single pass" process, instantizing is an integral part of the regular milk drying operation, using fluid milk as the basic ingredient. The "double pass" instantizing process, on the other hand, uses nonfat dry milk as the basic ingredient.

Comparison of differences between the "single" and "double pass" methods of making instantized nonfat dry milk indicates certain costs are not applicable to both processes in the same degree. For example, the cost of transporting powder from the drying plant to the instantizing plant would not apply to the "single pass" procedure since instantized powder is the end product of this process. In addition, the premium paid for Extra Grade powder used in the "double pass" method would most likely not apply to the "single pass" product. Undoubtedly, the amount of the premium would more than offset the cost of any additional drying procedure in the "single pass" process.

Much of the equipment used in constructing an instantizer consists of or is fabricated from standard production items such as heating coils, electric fans, and pumps. The instantizing plants themselves, however, often are custom designed to meet an individual company's specific requirements. Thus, an instantizing operation could be either an integral part of a butter-powder operation or an individual plant operation.

This report deals with the cost of instantizing nonfat dry milk in the "double pass" process, i.e., using nonfat dry milk powder as the raw material. The "double pass" system was selected for analysis because it is the process used in most of the instantizing plants listed in the July 1971 issue of Dairy Plants Surveyed and Approved for U.S.D.A. Grading Service (C&MS, USDA).

Processing and fixed investment costs were developed by the building block or economic engineering method and should not be viewed as representative of a specific instantizing operation (1, p. 771). However, they are attainable costs under normal operating conditions at the level of capital investment used, namely \$788,122. Thus, all cost estimates presented are optimal costs and are obtained on the basis of a model instantizing plant operating under certain assumed conditions. They may or may not correspond to actual operating costs today.

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<sup>1/</sup> Underscored numbers in parentheses refer to items in literature cited, p. 1.

## DEVELOPMENT OF COSTS

Assumptions

Five major assumptions were made to develop the model plant:

- (1) The rated and actual output of the instantizing equipment was 2,400 pounds of product per hour.
- (2) The packaging line was partially automated and operated at a rate of 4,500 pounds per hour or 18 4-pound cartons per minute.
- (3) In a normal workday, the instantizer operated for two 8-hour shifts, including  $\frac{1}{2}$ -hour startup or cleanup time per shift. The packaging line operated one 8-hour shift.
- (4) A workweek consisted of 5 workdays and a workyear was 240 workdays. This schedule permitted a nonoperating time allowance for weekends, 6 holidays per year, and normal equipment maintenance.
- (5) Only 20-quart (4-pound) cartons were used for packaging the instantized milk powder.

Capital Investment

Estimated capital investment required for the model plant used in this analysis was \$788,122 (table 1).

Table 1.--Estimated capital costs for a nonfat dry milk instantizing facility, 1971

Item	Estimated capital cost	Percentage of total capital cost	
		Dollars	Percent
Land (2 acres) .....	16,000		2.0
Building (17,425 sq. ft.)			
(Includes heating and air conditioning equipment) .....	302,769		38.4
Equipment:			
Powder handling and instantizing .....	322,941		41.0
Packaging .....	117,485		14.9
Miscellaneous			
(Includes laboratory, maintenance, office equipment) .....	28,927		3.7
Total capital cost .....	788,122		100.0

The figures in table 1 are based on published data and discussions with equipment manufacturers. The building dimensions were developed from Tracy's butter-powder plant plans (5, p. 4). Only those portions of the plant layout that would be required for an instantizing operation were used. It was assumed that at least 2 acres of land would be required for the building, parking facilities, and future plant expansion. All equipment cost estimates reflect the cost of the equipment, transportation expense from the manufacturers plant, and installation.

#### Personnel Requirements and Wage Rates

The type and number of personnel required to operate the model plant were based on information reported by Tracy (5, p. 27), Kerchner (3, p. 15-16), and Hanlon and Koller (2, p. 14). Table 2 shows the number of people that would be on duty for each shift and estimated 1971 hourly wage rates. The rates include fringe allowances for the model nonfat dry milk instantizing facility.

Table 2.--Personnel classifications and estimated hourly wage rates including allowances for fringe benefits used for model nonfat dry milk instantizing facility, 1971

Personnel classification	: Estimated 1971 : gross hourly : wage rate	Number	Number
		required for day shift	required for night shift
General administrative personnel			
General manager .....	\$9.285	1	0
Bookkeeper-payroll clerk .....	3.219	1	0
Clerk-typist .....	2.723	1	0
Plant administrative			
Plant superintendent .....	3.850	1	0
Chief engineer .....	3.850	1	0
Mechanic .....	3.850	1	0
Boiler room helper .....	3.438	0	1
Laboratory operator .....	3.541	1	0
Operating personnel			
Working foreman .....	3.610	1	1
Instantizer operator .....	3.528	1	1
Powder handler (warehouseman) ....	3.245	3	2
Packaging line operator .....	3.245	6	0
Cleanup man .....	3.245	0	1

Hourly wage rates for 1971 were developed by using 1965 wage rates and increasing them to an estimated 1970 figure. The change in the average weekly wage for production workers in the dairy products industry (SIC Code 202)

between 1965 and 1970, as reported by the Bureau of Labor Statistics, was used to raise the 1965 hourly rates to estimated 1970 levels. The reported 1965 average weekly wage was \$105.08. In 1970, it was \$135.29, a 28.75-percent increase. The 1970 rates were assumed to be applicable to 1971 and all personnel salary classifications to increase by the same percentage between 1965-70.

#### Proprietary Costs

In this study, proprietary or ownership costs include depreciation, taxes, interest, and insurance costs.

#### Depreciation

Annual depreciation expense was calculated for each item of equipment. The estimated life of the various pieces of equipment used in these computations were based upon those used by Kerchner (3, p. 53-58). Table 3 shows estimated annual depreciation expense for the model plant by major classes.

Table 3.--Estimated annual depreciation charges for nonfat dry milk instantizing facility, 1971

Item	Estimated annual depreciation charge	Percentage of total annual depreciation charge
Building (30-year life, \$10,000 salvage)...	8,234	14.2
Air conditioning equipment (10-year life, no salvage) .....	3,200	5.5
Heating equipment (25-year life, no salvage) .....	550	.9
Instantizing equipment (10-year life, \$10,000 salvage) .....	21,045	36.3
Powder handling system (10 years, no salvage 1/)	9,000	15.5
Packaging equipment (10 years, \$5,000 salvage) .....	11,248	19.4
Supplemental powder and warehousing equipment 2/ .....	2,591	4.5
Laboratory equipment 2/ .....	634	1.1
Maintenance and repair shop equipment 2/...	150	.3
Spare parts and personal convenience equipment 2/ .....	132	.2
Office equipment 2/ .....	1,238	2.1
<u>Estimated total annual depreciation</u> ....	<u>58,022</u>	<u>100.0</u>

1/ Forklift trucks and pallets included in this figure; at estimated 5-year life and \$1,000 salvage value, for forklift trucks only.

2/ Includes items for which varied life periods were used in estimating depreciation expense for this class of equipment.

### Taxes

Property taxes were estimated by using 55.3 percent (the ratio of the assessed value to sales value of commercial and industrial properties sold in Wisconsin in 1966 <sup>2/</sup>) of the book value as the appraised value for tax purposes. The tax rate applied to the appraised value was computed from Wisconsin Department of Revenue data for 1969 <sup>3/</sup>. It was obtained by dividing the total assessed agricultural land value into the total tax levied on personal property located in rural areas. The actual tax was estimated to be 3.2764 percent of the appraised value.

### Interest

The mid-life value of the building and major items of equipment were used to calculate annual interest costs. Powder handling, instantizing, and packaging equipment items were considered major items. The general formula--item value less salvage value divided by 2--was used to determine the mid-life value. Money was assumed to be available at a 10-percent interest rate.

### Insurance

Fire insurance, including extended coverage and boiler insurance, rates were based upon material in Kerchner's study (3, p. 20). A fire insurance rate of 36 cents per \$100 valuation and 80 percent of the value of all equipment and buildings was used in computing the annual premium. The boiler insurance premium used for the model plant was \$165 per year. Table 4 shows the estimated annual amounts used for the various items included under proprietary costs.

Table 4.--Estimated annual proprietary costs for a nonfat dry milk instantizing facility, 1971

Item	: Estimated annual expense	: Percentage of total annual proprietary cost
	: Dollars	Percent
Depreciation .....	: 58,022	54.9
Property taxes .....	: 14,279	13.5
Interest .....	: 31,032	29.3
Fire insurance (incl. extended coverage) ..	: 2,270	2.1
Boiler insurance .....	: 165	.2
Total annual proprietary cost .....	: 105,768	100.0

<sup>2/</sup> Taxation Property Values, 1967 Census of Governments, U.S. Bureau of the Census 1969; p. 47.

<sup>3/</sup> Wisconsin Department of Revenue, Bulletin 469, Madison, Wis., October 1970.

### Variable Costs

Variable costs include the cost of electricity, water and sewage, heating fuel, repair and maintenance, and general supplies.

#### Electricity

The consumption figure reported for butter-powder plants (7.1 kilowatt hours per 1,000 pounds of whole milk processed) was assumed applicable to 1,000 pounds of instantized nonfat dry milk (2, p. 29). The consumption rate includes all electricity used in the model plant. Monthly electric consumption was estimated by dividing the estimated annual kilowatt-hour consumption by 12 ( $8,640,000 \text{ lbs.} \div 1,000 \times 7.1 \text{ kw.-hr.} = 61,344 \text{ kw.-hr./yr. or } 5,112 \text{ kw.-hr./mo.}$ ). The reported electric costs per kilowatt-hour (3, p. 18) were used to convert this consumption figure to monthly and annual cost figures ( $5,112 \text{ kw.-hr./mo.} \times 1.55\text{¢/kw.-hr.} = \$79.236/\text{mo.} \times 12 = \$950.83/\text{yr.}$ ).

#### Water and Sewage

Water and sewage charges were obtained on the basis of cost per day (3, p. 22). Table 5 shows the daily water and sewage cost for these items used to compute an estimated total daily water and sewage cost for the plant.

Table 5.--Estimated daily water and sewage service expense for nonfat dry milk instantizing facility, 1971

Equipment or work area	Estimated	Percentage of
	daily expense	total daily expense
Instantizer (drying segment) .....	.110	89.5
Boiler .....	.02	1.6
Laboratory .....	.02	1.6
General office .....	.01	.8
General plant service .....	.08	6.5
Total daily water and sewage expense .....	\$1.23	100.0
Annual water and sewage expense .....	295.00	

The annual rate was computed by multiplying the daily figure by 240 working days.

#### Heating Fuel

It was assumed that the heating equipment was gas-fired, using either natural or propane gas for fuel. To calculate the fuel cost for this operation, it was necessary to estimate the hourly heating requirements for both

the building and process in terms of British Thermal Units (BTU). The procedure used to make these computations is that used by Tracy (5, p. 35). For this plant, the estimated total hourly BTU requirement was 2,230,910. The number of cubic feet of gas required was calculated on the assumption that 1,000 cubic feet of gas supplies 994,700 BTU's. It was estimated that 996,653 cubic feet of gas would be required each month at a cost of 37.2 cents per 1,000 cubic feet, or a total monthly cost of \$370.75 (3, p. 17).

#### Repairs and Maintenance

Annual costs of repair and maintenance operations were assumed to be half the annual building depreciation expense (table 3).

#### General Supplies

General supplies include office supplies, telephone expenses, bank charges, and miscellaneous office costs. Also included are the cost of plant uniforms and the expense of cleaning them. The daily cost of general and plant administration plus plant uniform and laundry costs are those reported by Kerchner (3, p. 20). Table 6 presents the estimated annual figures for the items included under variable costs.

Table 6.--Estimated annual variable costs for nonfat dry milk instantizing facility, 1971

Item	Estimated	Percentage of
	annual expense	total annual variable cost
Electricity .....	950	5.5
Water and sewage .....	295	1.7
Heating fuel .....	4,449	25.9
Repairs and maintenance .....	4,117	24.0
General supply .....	7,366	42.9
<u>Total annual variable cost .....</u>	<u>17,177</u>	<u>100.0</u>

#### Raw Material Specifications and Cost

The agglomerating or instantizing process does not change the quality of the milk powder during processing. The quality of the nonfat dry milk powder used as the raw material in the instantizing process must meet or exceed the grade standards established for U. S. Extra Grade instant nonfat dry milk powder.

Table 7 compares the U.S. Laboratory standard for regular and instantized grades of nonfat dry milk (NFDM).

Table 7.--Comparison of laboratory analysis standards for U.S. grades of nonfat dry milk

Laboratory test	Unit	Grade classification		
		Regular	Regular	Instantized
		Extra	Standard	Extra
1. Bacterial estimate	Standard plate count per gram	50,000	100,000	30,000
2. Butterfat content	Percent	1.25	1.50	1.25
3. Moisture content	Percent	4.0	5.0	4.5
4. Scorched particle content	Milligram	15.0	22.5	15.0
5. Solubility index U.S. high heat	Milliliter	1.2 2.0	2.0 2.5	1.0 ---
6. Titratable acidity	Percent	0.15	0.17	0.15
7. Coliform count	Gram	NR	NR	10
8. Dispersibility	Percent	NR	NR	85

Source: Title 7 CFR I, Part 58, Subpart b.- United States Standards for Grades of Nonfat Dry Milk (spray process); Subpart u.- U.S. Standards for Instant Nonfat Dry Milk.

Grade standards relating to flavor and odor plus physical appearance are identical for all classifications shown. However, there are different clump count standards for the Standard Grade NFDM powder and Extra Grade instant NFDM powder. To carry a Standard Grade rating, the clump count for regular NFDM powder cannot exceed 150 million per gram, while for the Instant Extra Grade powder this count cannot exceed 75 million per gram. In addition, a phosphatase test can be required for the instant NFDM, which cannot exceed 4 micrograms of phenol per milliliter. This test is not required for Regular Grade powders.

Higher grading standards for instant nonfat dry milk, compared with those for regular nonfat dry milk, require instantizer operators to use a higher grade powder than powder classified as Regular Extra Grade. Generally, the milk powder used in the instantizing process is a low-heat, Extra Grade spray dried powder that meets the grade standards for Instantized Extra Grade powders. A premium of  $\frac{1}{2}$  cent per pound over the price of Regular Extra Grade powder is

usually charged for this quality powder. This premium, along with the freight charge required to move the powder from the drying plant to the instantizing plant, is added to the price of Regular Grade powder to obtain a delivered price.

Although the instantizing process does not change the quality of the powder during processing, there is usually a powder loss associated with processing. This loss is in addition to any powder returned to the drying plant as unacceptable for not meeting buyer's specifications or other reasons. For this analysis, the processing powder loss is estimated to be 1½ percent of the plant's instantized powder production.

#### PROCESSING COSTS

##### Instantizing Process

Figure 1 presents a flow diagram showing the movement of milk powder through the instantizing and packaging process for the model plant. Briefly, the instantizing process, when powder is used as the basic raw material, consists of adding moisture to the powder, agglomerating the particles, and re-drying the powder. The flow chart shows product movement only through a packaging line used to package the instantized product in one consumer type package--a 20-quart or 4-pound carton. Other types of packaging lines for instantized powder are used in the industry as well, for example, plastic bags and laminated foil-paper bags.

The instantizing process can be used for products other than milk powder as for example, instant cocoa.

Patents for the basic instantizing process as well as the end product itself were issued in May 1958, and will continue in effect until 1975. As a result, a license fee or royalty is paid on a large percentage of the instantized nonfat dry milk made in the United States. Currently, this license fee amounts to ¼ cent per pound of instantized nonfat dry milk powder.

##### Cost Centers

To allocate costs, the analytical model was segmented into four cost centers: administrative; powder receiving, handling and warehousing; instantizing; and packaging. Table 8 shows the estimated building space, number of personnel, total daily payroll cost, and total annual payroll cost for each cost center. The following personnel were included under the administrative classification: General plant manager, bookkeeper-payroll clerk, laboratory technician, clerk typist, plant superintendent, chief engineer, mechanic, and boiler room helper. The salaries of the last four employees should be allocated to the other three cost centers. However, for convenience, they were included under the administrative category. The personnel included in the other major categories would be classified as general plant operating personnel.

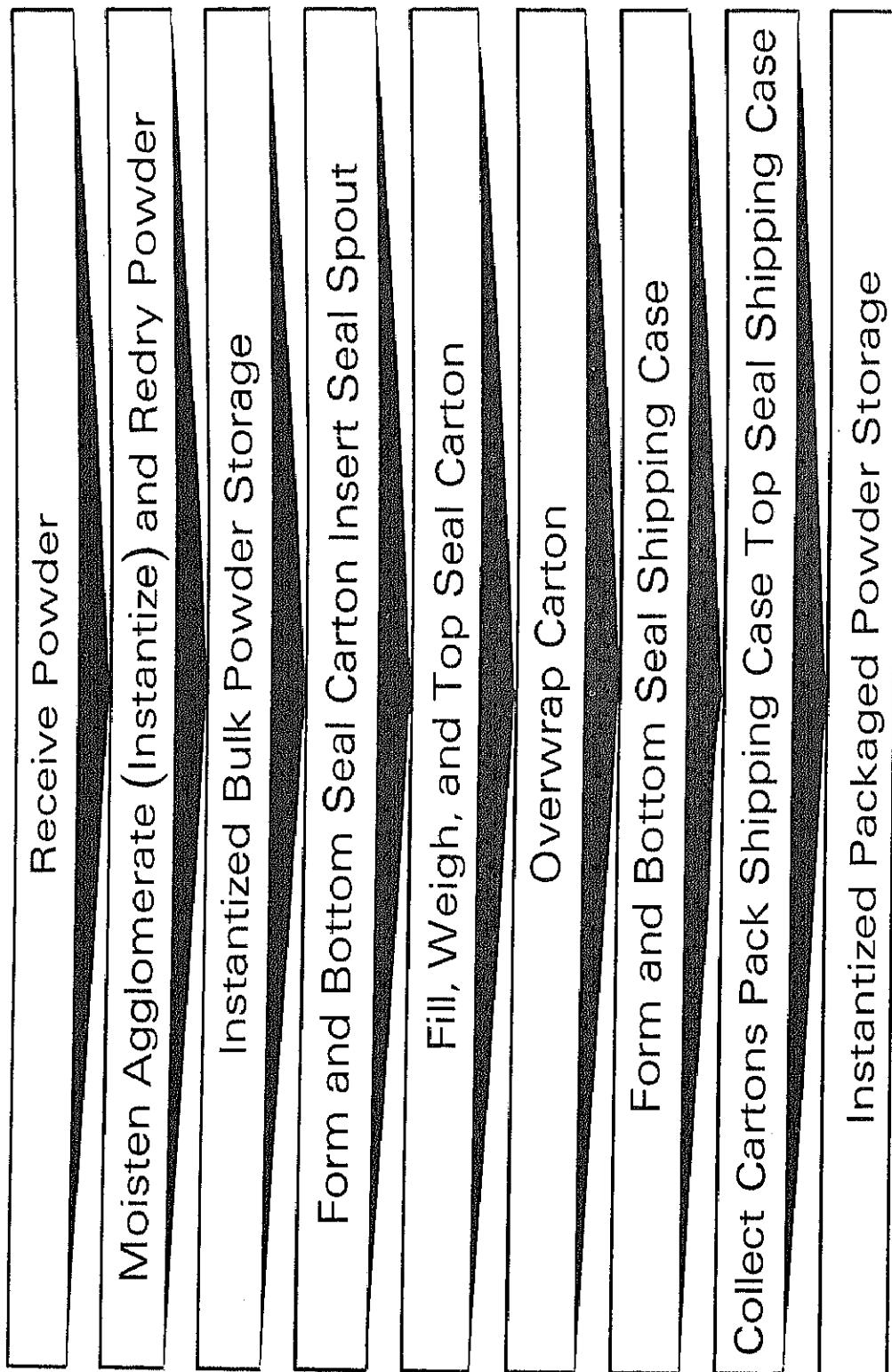


Figure 1. Flow Chart for Nonfat Dry Milk Instantizing Facility

Table 8.--Cost centers and specified allocations for analytical model nonfat dry milk instantizing facility, 1971

Items allocated	Unit	Costs by function				Packag- ing	Total
		Adminis- tration	and warehousing	Powder receiv- ing, handling,	Instan- tizing		
Bldg. space	Sq. ft.	3,925	7,200	3,300	3,000	17,425	
Personnel Reqd:							
Day shift	No.	8	3	2	6	19	
Night shift		0	2	2	1	5	
Total hourly salary cost:							
Day shift	Dol.	33.76	9.74	7.14	19.47	70.11	
Night shift		0.00	6.49	7.14	3.25	16.88	
Total annual salary cost		1/70,220	2/31,162	2/27,418	2/43,622	172,422	

1/ Based on 2,080-hour work year.

2/ Based on 1,920-hour work year. This figure used to compensate for equipment breakdown and other unpaid nonoperating time during the regular working year.

**Estimated Annual Operating Cost**

Table 9 shows the estimated annual operating costs for the plant. These figures assume annual instantized powder production of 8,640,000 pounds packed in 2,160,000 20-quart cartons (reconstituted basis) and further packed 6 cartons per case in 360,000 shipping cases.

The individual expense items were allocated to the separate cost centers by various means. For example, equipment depreciation was allocated on the basis of the relationship of the value of the equipment used by the specified center to the total plant equipment value, and building depreciation on the relationship of the square footage of space assigned to the cost center to the building's total amount of space. Generally, the expense items were distributed on the basis of estimated degree of use by cost area.

In this instance, packaging operations accounted for 61.9 percent of total operating costs, instantizing 13.6 percent, administration 14.9 percent, and powder receiving, handling, and warehousing 9.6 percent. These figures, when converted to a cost per pound basis, using the 8,640,000-pound figure as a base, are 0.9 cent for instantizing, 1.0 cent for administration, 0.7 cent for powder receiving, handling and warehousing, and 4.2 cents for packaging. The instantizing figure ranges from slightly more than two-fifths to two-thirds of the figures reported by Purcell for 1958 (4, p. 21).

Table 9.-Estimated annual operating costs for nonfat dry milk instantizing facility, 1971

Item allocated	Powder receiving handling & warehousing	Instantizing	Packaging	Total	
	Percent	Dollars	Percent	Dollars	Percent
	Percent	Dollars	Percent	Dollars	Dollars
Salaries .....	70.220	31,162	27.418	43,622	172,422
Equipment depreciation .....	2,153	11,91	21,045	11,249	46,038
Building depreciation .....	1,853	3,409	1,556	1,416	8,234
Air condition depreciation .....	800	000	1,600	800	3,200
Heat equipment depreciation .....	91	92	1,275	291,773	550
Packaging materials .....	(20.0)	190	(5.0)	356	356
Electricity .....	(33.5)	99	(20.7)	(37.5)	291,773
Water & sewer .....	(7.0)	312	(3.0)	49	950
Heating fuel .....	(7.7)	1,100	(19.2)	(29.2)	295
Property taxes .....	7,366	133	(75.0)	86	4,449
General supplies .....	(10.0)	412	(10.0)	3,337	667
Repairs & maintenance .....	(22.5)	511	(41.4)	(15.0)	14,280
Fire insurance .....	(7.7)	41	(41.4)	6,868	3,570
Boiler insurance .....	2,389	(19.2)	5,958	(25.0)	7,366
Interest .....					2,270
Total	87,537	56,588	79,548	363,467	587,140
Percentage	14.91	9.64	13.55	61.90	100.00
Est. cost/lb. instantized powder	\$ .0101	\$ .0065	\$ .0092	\$ .0421	\$ .0679

Note: Figures in parenthesis indicate portion of total annual expenditures allocated to specific cost center.

#### Estimated Instantized Powder Cost

The 1971 Commodity Credit Corporation support purchase price of 31.70 cents per pound for NFDM powder was used as the basic powder price for this analysis. Powder loss due to processing was calculated to be  $\frac{1}{2}$  cent per pound of instantized product produced--1 $\frac{1}{2}$  percent of the total annual instantized powder output multiplied by the basic powder price plus premium and freight, divided by the total annual instantized powder production. Table 10 presents a breakdown of the total estimated cost of instantized nonfat dry milk powder. The 40.74-cent per pound cost figure includes costs up to placing the final product in the warehouse, but does not include any allowance for return on investment, Federal, State, or local income taxes, or taxes other than real property.

Table 10.--Estimated cost per pound of instantized nonfat dry milk powder packed in 20-quart cartons, 1971

Factor	Labor	Material	Overhead	Total	Percentage of total packaged cost
	Cents/lb	Cents/lb	Cents/lb	Cents/lb	Percent
<b>Raw material</b>					
Nonfat dry milk powder low heat Extra Grade .....	-	-	-	31.70	77.8
Premium for instantizing grade powder .....	-	-	-	.50	1.2
Freight (drying plant to instantizing plant) .....	-	-	-	1.00	2.5
<b>Total raw material cost .....</b>				<b>33.20</b>	<b>81.5</b>
<b>Instantizing and packaging</b>					
Administrative .....	.81	-	.20	1.01	2.5
Powder receiving, handling, and warehousing .....	.36	-	.29	.65	1.6
Instantizing .....	.32	-	.60	.92	2.3
Processing powder loss .....	-	-	.50	.50	1.2
Process license fee .....	-	-	.25	.25	.6
Packaging .....	.50	3.38	.33	4.21	10.3
<b>Total instantizing and packaging cost .....</b>	<b>1.99</b>	<b>3.38</b>	<b>2.17</b>	<b>7.54</b>	<b>18.5</b>
<b>Total instantized powder cost .....</b>				<b>40.74</b>	<b>100.0</b>

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